

Fuel/Oxidizer Injector Modeling in Sub- and Super-Critical Regimes for Deep Throttling Cryogenic Engines, Phase I

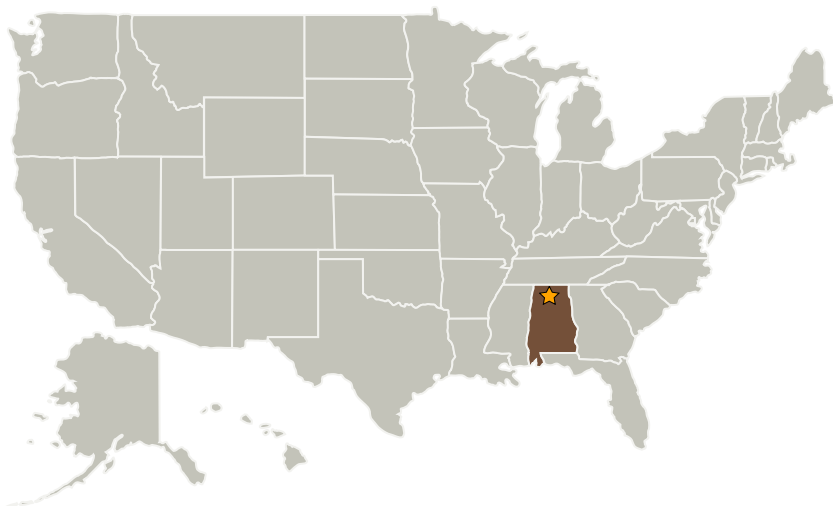
Completed Technology Project (2008 - 2009)



Project Introduction

Accurate CFD modeling of fuel/oxidizer injection and combustion is needed to design and analyze liquid rocket engines. Currently, however, there is no mature modeling capability for liquid fuel/oxidizer injectors in LOCI-Chem, used by NASA and its contractors to analyze rocket engines. In this STTR, an innovative, high fidelity injection module will be developed that features the Level Set (LS) interface tracking method coupled with Adaptive Mesh Refinement (AMR). In addition to tracking liquid atomization for subcritical flows, the module will have the capability to model transcritical and supercritical regimes, as well as transient and steady operating conditions in a cryogenic engine combustion chamber. CFDRD will team with Mississippi State University to develop the proposed unified module in LOCI-Chem. To show feasibility, the Phase I effort will implement the LS method to track liquid-gas interfaces, and resolve the primary atomization of liquid jets in a subcritical environment. Validation will be performed using the shear coaxial LN₂/GN₂ jet data of AFRL (Edwards AFB). In Phase II, the LS module will be coupled with the Lagrangian spray model in LOCI-Chem in order to completely track the spray. AMR capability will be developed and integrated with the LS module to improve LS's liquid mass conservation accuracy. Models for secondary atomization and drop vaporization will be implemented in Phase II, in addition to thermodynamic models to capture transcritical and supercritical combustion. Final demonstration of the software will include validation against practical liquid propellant injector cases selected in consultation with NASA personnel.

Primary U.S. Work Locations and Key Partners



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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Marshall Space Flight Center (MSFC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

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Organizations Performing Work	Role	Type	Location
★ Marshall Space Flight Center (MSFC)	Lead Organization	NASA Center	Huntsville, Alabama
CFD Research Corporation	Supporting Organization	Industry	Huntsville, Alabama

Primary U.S. Work Locations

Alabama

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Sarma Rani

Technology Areas

Primary:

- TX14 Thermal Management Systems
 - └ TX14.1 Cryogenic Systems
 - └ TX14.1.5 Cryogenic Analysis, Safety & Properties